Monitoring plastic pollution in the context of the Global Plastics Treaty

Monitoring is repeated systematic measurement to detect changes over time in relation to a starting point or 'baseline'. Monitoring will be essential to assess progress in reducing plastic pollution and to inform any further actions necessary for the success of the Global Plastics Treaty[1]. Plastic pollution occurs throughout the life cycle of plastics, including releases and leakages of pre-production pellets and powders, intact items, fragments, micro- and nanoplastics, and chemicals associated with plastics. This policy brief considers the advantages and disadvantages of monitoring approaches of relevance to Articles in the Chair's text of 1/12/2024[1] that are focused on reducing plastic pollution (**Appendix 1**).

Monitoring in the natural environment (downstream)

Solid items, often referred to as plastic debris, range from agricultural mulch films and fishing gear, hundreds of metres in length, through everyday items like packaging, to micro- and nanoplastics[2]. This debris can be redistributed by wind and water, including by floods and hurricanes[3,4], leading to widespread dispersal and deposition across multiple environmental compartments including soils, freshwater and marine habitats and biota. Monitoring in the environment is of relevance to Article 9. However, despite the durability of plastics and increases in the quantities of debris released to the environment, evaluation of existing monitoring regimes typically indicates extensive long-term sampling effort is required to detect substantial changes (20–50%) in abundance[5–7].

Monitoring of macroplastics by citizen scientists potentially offers an inexpensive way to help provide the necessary sampling effort in habitats that are prone to high levels of dispersal such as beaches[8]. Alternatively, levels of intrinsic data variability can be reduced by monitoring at **locations where substantial quantities of debris, including microplastics, could be released to, or removed from, the environment** (**Fig 1**), for example near to sewage outfalls, and plastic production facilities or debris captured by clean-up devices. Monitoring **non-tidal rivers as pathways for pollution** can also provide valuable data on sources further up the river system[9,10]. Emerging approaches including cameras on bridges, boats and drones together with image recognition offers the potential to collect data at the greater levels of replication required to detect change once plastic debris has dispersed in the environment[11,12].

Targeted environmental monitoring of readily visible items of debris that are subject to upstream or midstream supply chain interventions (e.g. Articles 3–6) can be more effective than monitoring the total amount of debris in the environment[13] (**Fig 1**). For example, there is evidence of a decline in the abundance of plastic bags on beaches following taxation[14]; and in the abundance of plastic bottles after introduction of deposit return schemes[15]. However, the transboundary movement of plastic pollution in the environment is a major obstacle to detecting the effectiveness of national level interventions[16] and is especially problematic on the coastlines of oceanic islands.

Monitoring plastic chemicals in food, drinking water and beverages; at points of environmental release, and within natural systems is well established;[17,18] and is essential to ensure food safety and environmental protection. Biomonitoring in humans could also be used to assess chemicals associated with plastics (Article 19). However, there are multiple potential sources of these chemicals and attribution becomes increasingly challenging as they disperse away from sources (**Fig 1**).

Monitoring upstream–midstream

Plastic pollution including from micro- and nanoplastics and plastic chemicals is most effectively addressed through interventions along supply chains (Articles 3–8)[1]. Monitoring coupled to upstream (polymer production and trade in polymers) and especially midstream (product manufacture and trade in products) interventions is advantageous because it can provide information relevant to potential downstream releases, as well as on the effectiveness of such interventions (**Fig 1**). For example, because waste management alone will not be able to keep pace with increasing waste generation, monitoring polymer production and trade (Article 6) will be crucial to understanding subsequent risks of pollution[19]. The World Trade Organisation is working to increase the availability of trade data via its Dialogue on Plastic Pollution (DPP) which aspires to improve transparency, granularity and reporting, for example via the **Harmonized Commodity Description and Coding System** (HS codes)[20], improved classification of products containing plastics (e.g., plastic coatings) and compilation of quality-assured and quality-controlled publicly available databases. However, DPP's recommendations are voluntary and are not directly guided by independent expertise. Progress

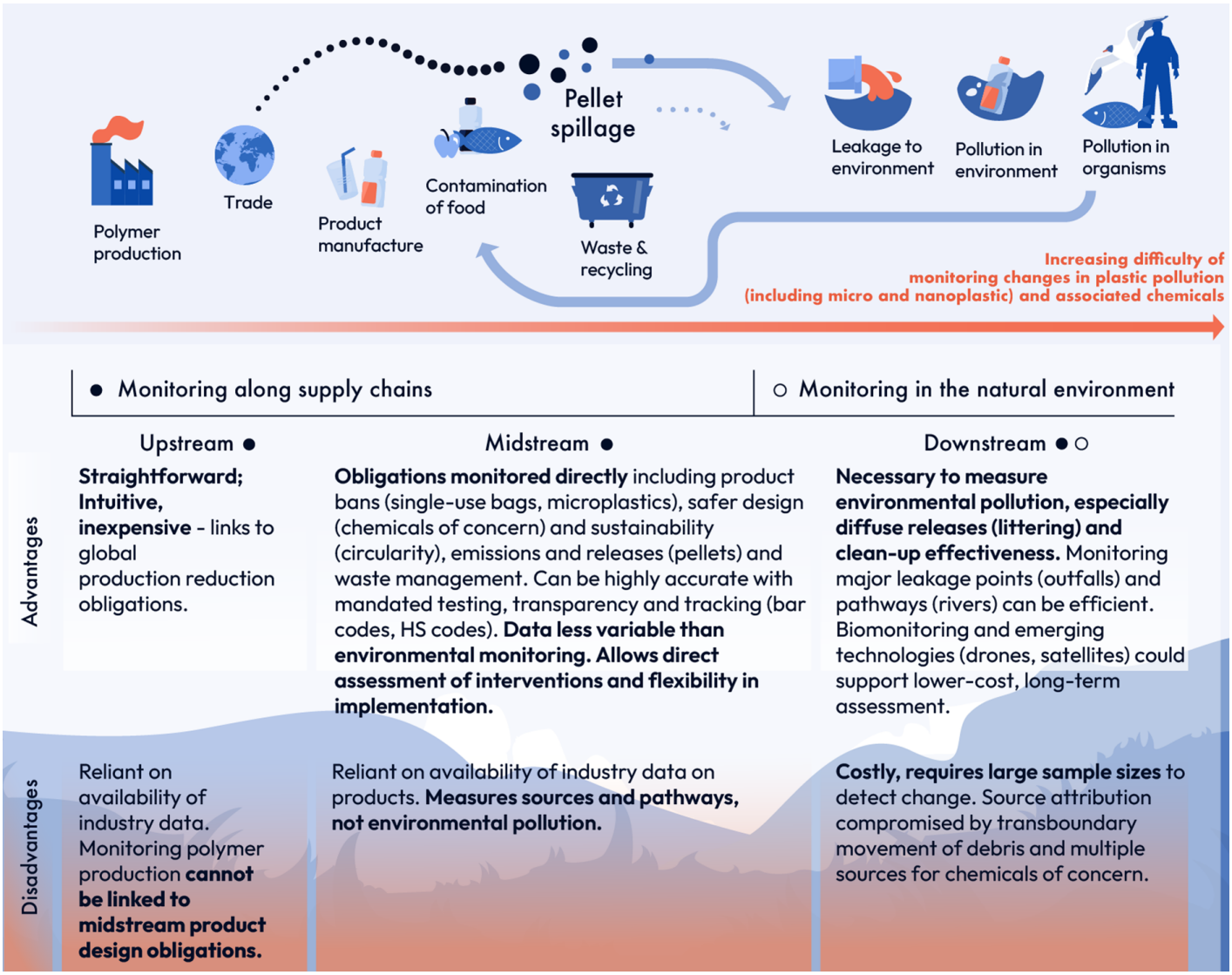

Figure 1. Potential sources of plastic pollution illustrating the advantages and disadvantages of upstream-midstream monitoring compared to downstream monitoring in the natural environment

is also hindered by a lack of environmentally relevant testing, which would be required to support trade in **safer, more sustainable, and less polluting products** (Articles 3 and 5)[21,22].

When policy requirements are clear and evidence-based, monitoring compliance for products in trade (Article 13) can be relatively routine. For example, the EU ECHA legislation on **intentionally added microplastics**[23] is grounded in scientific evidence and monitoring microplastics in products is far more straightforward than monitoring them in the environment (Fig 1). Some countries already have well established product monitoring protocols for chemicals of concern, for example in toys, and medical applications. This approach could be extended to ensure the safety and sustainability of a wider range of products and waste, for example as a means of testing and regulating plastic destined for recycling.

National level data on quantities of managed and mismanaged waste as well as exports (Article 8) can be subtracted from production and import data (consumption) to estimate any remaining, unaccounted for, plastics released to the environment. For example, data on waste collection rate, waste in managed collection facilities, uncontrolled disposal and open burning may be available from official national data sets. Mandating reliable national monitoring and reporting on production and trade in plastics (e.g. as pellets), plastic products, chemicals and waste, including mismanaged waste is crucial to transparency and could help facilitate a just transition (Article 10) and guide national plans (Article 14). Such data can also be combined with waste characterisation data according to type and composition to quantify releases of specific materials and chemicals (Article 7)[24].

Mandating reliable national monitoring[25] **and reporting on production and trade in plastics** (e.g. as pellets)**, plastic products, chemicals and waste, including mismanaged waste** is crucial to transparency and could help facilitate a **just transition**[26] (Article 10) and guide national plans (Article 14)[1]. Reporting and transparency of plastic products, and products marketed as alternatives and substitutes to plastics, will also support **innovation and trade in safer, more sustainable products** (Articles 3 and 5)[21,22]. To be effective and trusted, development of monitoring approaches and data interpretation requires support and guidance from experts free of conflicts of interest with Treaty outcomes (Article 20bis). Technical and capacity building will also be essential to ensure local availability of facilities and expertise (Article 12)[1]; concurrent monitoring could also be used to demonstrate subsequent progress against Treaty obligations. In addition to monitoring, there may be requirements to report (Article 15) on obligations supporting treaty implementation (Articles 10–18)[1].

Conclusions

Plastic pollution arises from many sources and is transported through multiple pathways. Addressing this challenge will require safety and sustainability criteria for products, supported by standards and labelling, together with targeted monitoring, mandatory transparent reporting, and accessible data on the effectiveness of interventions relative to baselines and targets. Monitoring that is tightly coupled to specific upstream-midstream interventions is likely to be effective because it is less prone to variability than monitoring in the natural environment. Despite the associated challenges, long-term environmental monitoring will be also required to assess the overall effectiveness of multiple interventions in addressing the aspirations of the Treaty.

1, Objective; **2**, Definitions; **3**, Plastic Products; **4**, Exemptions; **5**, Plastic Product Design; **6**, [Supply][Sustainable Production]; **7**, Releases and Leakages; **8**, Plastic Waste Management; **9**, Existing Plastic Pollution; **10**, Just Transition; **11**, Financial [Resources and] Mechanism; **12**, Capacity Building, Technical Assistance and Technology Transfer, Including International Cooperation; **13**, Implementation and Compliance; **14**, National Plans; **15**, Reporting; **16**, Effectiveness Evaluation; **17**, Information Exchange; **18**, Public Information, Awareness, Education and Research; **19**, Health; **20bis**, Subsidiary Bodies

Appendix 1. Articles in the Chair's text of 1/12/2024[1] that are focused on reducing plastic pollution. This version of the text was selected because it is currently the last version to be accepted by the whole of the INC as the basis for further discussion and contains key elements expressed in later versions.

Authors: Richard Thompson, Winnie Courtene-Jones, Amy Lusher, Montserrat Filella, Francesca De Falco, Karin Kvale, Maria Isabel Criales Hernandez, Florin-Constantin Mihai.
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